AD-A197 354

A Survey of Expert System Development Tools

Michael J. Liebhaber
Vreuls Research Corp.

Sharon L. Riedel
Army Research Institute

for

Contracting Officer's Representative
Jon J. Falleson

Ari Field Unit at Fort Leavenworth, Kansas
Stanley M. Halpin, Chief

Systems Research Laboratory
Robin L. Keesee, Director

DTIC
SELECTED
JUL 0 8 1988
☞H

U. S. Army
Research Institute for the Behavioral and Social Sciences

June 1988

88 06 081

U. S. ARMY RESEARCH INSTITUTE

FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency under the Jurisdiction of the

Deputy Chief of Staff for Personnel

EDGAR M. JOHNSON
Technical Director

L. NEALE COSBY
Colonel, IN
Commander

ADA197354

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION	1b. RESTRICTIVE MARKINGS
Unclassified	- -

2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION / AVAILABILITY OF REPORT
- -	Approved for public release;
2b DECLASSIFICATION / DOWNGRADING SCHEDULE	distribution unlimited.
- -	

4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
- -	ARI Research Note 88-40

6a NAME OF PERFORMING ORGANIZATION	6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION
Vreuls Research Corporation		ARI Field Unit at Fort Leavenworth

6c. ADDRESS (City, State, and ZIP Code)	7b. ADDRESS (City, State, and ZIP Code)
68 Long Court, Suite E Thousand Oaks, CA 91360	P.O. Box 3407 Ft. Leavenworth, KS 66027-0347

8a. NAME OF FUNDING / SPONSORING ORGANIZATION	8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
U.S. Army Research Institute	PERI-SZ	MDA903-85-C-0120

8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS			
	PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO	WORK UNIT ACCESSION NO
5001 Eisenhower Avenue Alexandria, VA 22333-5600	6.27.17	2Q1627 17A790	1.4.4.	1.4.4.C2

11. TITLE (Include Security Classification)

A Survey of Expert System Development Tools

12. PERSONAL AUTHOR(S)
Michael J. Liebhaber, Vreuls Research Corp / Sharon L. Riedel, U.S. Army Research Institute

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final Report	FROM June 84 TO June 87	June 1988	81

16. SUPPLEMENTARY NOTATION Jon J. Fallesen, contracting officer's representative.
Citing commercial products in this report does not constitute an endorsement by ARI or
Vreuls Research Corp.

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Expert System Development Tools Decision Aiding
			Knowledge Representation, Expert Systems
			System Requirements

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This research note is a brief review of ninety-three Expert System Development (ESD) tools identified in the open literature fron 1984 to 1987. An ESD tool is one or more computer programs that facilitate the process of building an expert system. Most ESD tools form an integral part of the completed expert system, providing a mechanism for controlling the operations of the system, and a method for interacting with the knowledge base. The purpose of this research note is to guide searches and evaluations of Expert System Development Tools by those responsible for creating expert systems.

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	Unclassified

22a NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE (Include Area Code)	22c. OFFICE SYMBOL
Jon J. Fallesen	913/684-4933	PERI-SL

DD Form 1473, JUN 86   Previous editions are obsolete.   SECURITY CLASSIFICATION OF THIS PAGE

i

A SURVEY OF EXPERT SYSTEM DEVELOPMENT TOOLS

EXECUTIVE SUMMARY

Requirement:

A need exists, especially for first-time developers, to learn the types of tools which exist to aid the development of expert systems. Knowledge of these tools provides the option to acquire an existing tool which best meets the need, or build a tool. If already developed software can be used, it usually is more cost-effective to buy than to create such software from scratch.

Procedure:

Existing Expert System Development (ESD) tools were surveyed covering the period from 1984 to early 1987. Included in the survey were product announcements, reviews of existing tools, reports of tool-use in research and applied settings, information obtained from a workshop on ESD tools, and discussions with tool users. A list of important ESD tool features was developed from the literature on expert systems. It included the following general features: Knowledge Representation, Control and Inference, Certainty Management, Hypothesis Handling, Knowledge Acquisition, User Interface, and External Access. Within these general features, subfeatures also were listed and defined. Additional information also was given regarding availability, cost, vendor support and address, system requirements, and typical applications if they were known.

Findings:

Ninety three (93) existing ESD tools were described in terms of their features, which are defined in the main body of the report. The tools are listed in Appendix A, and the full description of the features of each tool is contained in Appendix B.

Utilization of Findings:

This report can serve as a reference to expert system developers or managers who need to learn what ESD aids are available and their general features, constraints, and costs. An in-depth analysis of these tools for any given type of application was not performed because such an analysis would depend on the particular application.

It was noted that ESD tools are being developed constantly, thus this report captures only those tools which could be found readily at the time of the study.

Distribution/

	Availability Codes
Dist	Avail and/or Special
A-1	

DTIC
COPY
INSPECTED
6

iii

A SURVEY OF EXPERT SYSTEM DEVELOPMENT TOOLS

CONTENTS

LIST OF TABLES

A SURVEY OF EXPERT SYSTEM DEVELOPMENT TOOLS

INTRODUCTION

This is a brief review of ninety-three Expert System Development (ESD) tools. The purpose of this review is to provide an overview of available tools and to guide searches and evaluations of Expert System Development Tools by those persons who are directly responsible for creating an expert system. The survey provides a quick overview of many tools. As such, it will benefit first-time expert systems developers who are given the task of choosing a development tool. It is assumed that the reader has been exposed to expert systems at some level. Experienced users may also find the survey useful for comparison of the tools they are using with other tools.

An ESD tool is actually one or more computer programs that facilitate the process of building an expert system. However, first-time ESD users should be aware that the need for a tool does not stop at the end of an expert system's development cycle. Most ESD tools form an integral part of the completed expert system; providing a mechanism for controlling the operation of the system and a method for interacting with the knowledge stored in the knowledge base.

This survey does not rate or otherwise assess the value of particular ESD tools for two reasons. The first is to avoid biasing the reader against products for which only a limited amount of information is available. Second, it would be beyond the scope and resources of this survey to completely test all of the tools to the level required by experienced users. This is partly because standard benchmarks for testing ESD tools do not exist. Benchmarking expert systems is still in the conceptual phase with much of the debate centered on what would constitute an adequate test of a knowledge-based system. Opinions were divided at a recent workshop (RAND/DARPA Expert System Tool User's Workshop, Santa Monica, CA, 1986) on ESD tools, but most agreed that standard "number crunching" benchmarks were inadequate for testing expert system performance.

The survey is not intended to provide the final say in the selection of a tool for developing a particular expert system. Rather, it should be used to give the first-time user a general overview of existing ESD tools and to guide the tool selection process. All tools have certain features that make them more or less suited for a particular type of problem and most tools can be applied to various types of problems (e.g., control, diagnosis, planning, etc.) as long as the user is aware of the tradeoffs that must be made. For example, a tool that does not have uncertainty management may have difficulty working in a domain where there are few data to support conclusions. For more details on the selection of a tool for a particular problem see Bobrow, Mittal, and Stefik (1986), Cromarty (1985), Harmon and King (1985), and Waterman (1986).

The goal of this survey is to present as much information about as wide a variety of tools as possible. However, with new tools being developed almost monthly, and to accurately describe the main capabilities of each tool, the inclusion of all tools is impossible. Hopefully, the survey accurately reflects the main capabilities of each tool, but it is incomplete since much of the information is from press releases and short review articles from the past two years. Programming languages such as C, LISP, and Prolog are not included in the survey since their functionality extends beyond expert system development.

The tools and features are from various sources including those already mentioned and from AI Magazine (1986), Brachman and Schmolze (1985), Bundy (1984), Bylander and Mittal (1986), Charniak and McDermott (1985), Fox, Wright, and Adam (1985), Kline and Dolins (1985), Winston (1984), and from personal communication with some ESD tool users. See these sources for further discussion of particular tools and their features. The survey covered the period from 1984 to early 1987.

This survey is broken into two parts, first a description of the tool features, and then an index to the 93 tools. A list of the tools appearing in this survey is in Appendix A and information on the individual tools is in Appendix B.

EXPERT SYSTEMS DEVELOPMENT TOOL FEATURES

Features are programming techniques and other methods and practices that ESD tools use to facilitate expert system development. Features may be implemented differently from tool to tool, however, the function should be similar. That is, the result of Feature X in tool A is the same as Feature X in tool B. If a tool in Appendix B does not have an entry for a particular feature it does not necessarily mean that the tool lacks that feature, just that it was not mentioned in any of the sources.

The features are loosely divided into seven groups: Knowledge Representation, Control and Inference, Certainty Management, Hypothesis Handling, Knowledge Acquisition, User Interface, and External Access. Features are alphabetically ordered within each group. In practice, these groups and the features within them overlap quite a bit. However, the categories do capture the elements that are essential for comparison across ESD tools.

Knowledge Representation

Knowledge representation refers to how data storage is organized. In general, full-featured tools offer two or more representation methods.

Accessed-based knowledge is in the form of procedures that are accessed or triggered by changes in data values or by messages (see Objects/etc. below). The procedures are usually called demons or active values and serve to initiate further computation.

Decision trees (or matrix) are branching networks of conditional tests, usually used in classification problems or state transitions.

Hierarchy is a layered knowledge organization where a lower layer is subordinate to the layer immediately above it and so on. A tool may contain single or multiple hierarchies. Hierarchies provide a natural vehicle for inheritance (discussed under Control & Inference below).

Logic-based systems contain knowledge which is expressed in logical clauses. Predicate calculus is used to control execution. This method is typically found in Prolog-based tools.

Networks are a method of organizing knowledge into an interconnected (lattice) hierarchy. Network type is taken from the kinds of relations that hold among the nodes. Semantic nets, where the relations specify the meaning of a node, are the most common.

Objects/classes/frames are any type of knowledge structure that treats an organized subgroup as a separate, but complete, entity. Each entity has its own characteristics as well as those inherited from higher-level enti-ties. Most tools allow entities to pass messages to one another.

Procedures and rules refer to knowledge that is organized into con-ditional rules or sets of rules. This category contains tools that did not state explicitly that they use access- or object-based representation.

Spreadsheet/database are systems whose knowledge is stored in a spreadsheet or data base format.

Control and Inference

These are methods for controlling execution, the sequence of rule application, and problem solving. Certainty Management and Hypothetical Reasoning are discussed separately.

Agenda mechanism is a method where rules, procedures, and other items to be processed are selected from a prioritized or weighted list.

Algorithms are predetermined methods for executing the rules of an expert system (e.g., a tree traversal routine); they are used to control processing.

Blackboard is a type of data base that is used as a common com-munication point for multiple knowledge bases. It is generally used in cooperative problem solving so that one problem solving routine can view the intermediate results of the others.

Chaining/rule application. Five chaining/rule applications are described below.

3

Backward chaining is the method of deducing facts from conclusions (i.e., going backwards from a goal to the supporting facts). If the facts are true then the goal is assumed to be true: for example, CONCLUSION (Mary has a cold) IF FACTS (temperature > 99°F and has runny nose). Backward chaining is also called goal driven or deductive reasoners.

Forward chaining is a method for inducing conclusions from known facts: using the above example, IF FACTS (temperature > 99°F and has runny nose) THEN CONCLUSION (Mary has a cold). Forward chaining sometimes is referred to as data driven or inductive reasoners.

Parallel refers to systems that apply rules simultaneously.

Recursive/nested rule applications allow routines that can call themselves or that can contain embedded routines.

Sequential/rule order control simply proceeds sequentially from one rule to the next; that is, rules are used in the order they appear in the knowledge base.

Constraint or belief propogation is a method for imposing constraints on data values through successive stages of processing. It is usually done with explicit constraint application operators.

Default values are predetermined or inherited values that can take the place of missing values. They usually occur in the context of frames and objects.

Inheritance is the means by which entities in a network can take on attributes of related, higher-level entities. For example, bats have a unique attribute among mammals: they CAN-FLY; but, they also inherit attributes common to all mammals such as: HAS-HAIR.

Meta-reasoning refers to any method that a system has for observing and modifying its own behavior.

Pattern matching is simply comparison between a data structure and a stored generalized pattern. The exactness of the match can be variable (fuzzy).

Problem solving. Two problem solving methods are described below:

Classification is the categorization of entities or rules into predetermined classes.

Conflict resolution is a strategy for choosing among alternatives, especially among viable rules. Examples include choosing the most specific rule or choosing the rule with the most constraints.

Resolution is a logical inference method for deducing a clause from two well-formed parent clauses. Resolution is used most often in Prolog-based systems.

Search. Six search methods are described below.

Backtracking, chronological (or depth-first) is a method used to correct faulty inferences. When an unacceptable result is generated the system backs up to the most recent decision point that has an unexplored alternative, removes all conclusions below that point, and proceeds forward down the alternative path.

Backtracking, dependency-directed is similar to chronological backtracking except that the only paths searched are those upon which the current, failed state depended; that is, not all conclusions are removed.

Breadth-first is a method for searching all nodes in a given level of a tree before proceeding down to the next level.

Opportunisitic search uses the best available strategy and information to incrementally work towards a solution.

Pruning, minimax is a method for eliminating search paths along a tree that are not the minimum or maximum value for a given level.

Pruning, shallow is another method for elimination of search paths that appear irrelevant after a minimal amount of look ahead.

Time-dependent control rules are tagged with the time they were last applied. They are used generally in conflict resolution (e.g., use the most recently fired rule).

Truth maintenance system is a method for keeping track of justifications, true and false, for all conclusions. It is useful for explaining why an inference was made by the system.

Certainty Management

Most tools provide some mechanism for handling uncertain information. The most common is to assign a priori weights to known facts (i.e., 80% certain that fact A is true).

Fuzzy logic/sets refer to tools that use fuzzy set theory (i.e., set membership is graded rather than all or none). Therefore, they can reason with incomplete information.

Probability, Bayesian statistical inferences can be made using Bayes' theorem or any other similar method that involves the use of prior and unconditional probabilities.

Probability, confidence/certainty factors are numerical values that express an expert's or user's belief that a given fact is true.

Hypothesis Handling

These are methods that allow an expert system to keep track of what happens under different hypotheses.

Hypothetical worlds refer to the ability to track altenative results and facts (e.g., What if the result of RULE-n had been B instead of A?).

Model directed refers to the use of a model of the world to generate possible solutions and then testing each solution against the model until a satisfactory fit (i.e., solution) is achieved.

Multiple, alternative data bases are methods for creating hypothetical worlds.

Multiple lines of reasoning are attempts to solve a problem simultaneously from different points of view. For example, the simulation of high risk and low risk strategies.

Knowledge Acquisition

These are routines geared especially to enter knowledge (rules and facts) into the expert system. Most tools allow the user to directly enter rules and facts.

Conflict detection is the automatic ability to tell when a new rule conflicts or is inconsistent with existing facts and rules.

Explicit rule entry means that rules can, or must, be entered explicitly by the user. See induced rules below.

Fact and control knowledge are the abilities to separately enter factual and/or control knowledge into the knowledge base.

Knowledge base editor provides ways (e.g., syntax and consistency checking) to change facts and rules in the knowledge base or for adding new knowledge.

Rules induced means that the tool can induce rules from examples or data. Usually the system will prompt the user for verification of a new rule before it is entered into the knowledge base.

User Interface

These are facilities for interacting with the ESD tool. Most tools make use of more than one method.

Command language communication uses terse or mnemonic commands.

Debugging aids are facilities that allow the ESD tool user to monitor the development of the expert system. These usually take the form of a trace of rule firings, the ability to break into the system at various points while it is executing, and help screens for when the user has problems.

Explanation and history refers to the ability to explain and track all inferences. They also include routines to answer questions on how or why a particular inference was made or rule was used. History is simply a record of all rules that were used during a given run of the system.

Forms or reports provide pre-formatted output forms or reports. Some tools allow the user to alter the format of the reports.

Graphics or graphic primitives mean that the ESD tool has some type of graphics capability; usually in conjunction with a mouse input device. Some packages provide routines (primitives) for developers to design their own graphical interface.

Menus and prompts are any type of screen display where the designer has a choice of responses or is asked for a particular response.

Mouse is an input device which can or must be used for some of the input to the system.

Restricted natural language is communication with the user in something more than commands and prompts and less than English. This includes all tools that reported having a Natural Language interface. Almost all tools use pattern matching to "read and write" rather than true natural language understanding.

Voice indicates that voice input or output can be used.

Windows divide the screen into windows or provides windowing capability.

External Access

This category includes methods for allowing the tool to make use of non-tool information such as data bases and other software routines.

Data bases, spread sheets, and other indicate that the ESD tool can use commercial packages (e.g., LOTUS 123) or user defined external data sources. This includes statistics and graphics packages.

Languages denote the language in which the tool is written and/or languages that the tool can read and use. Languages denote that which can be used to program procedures that the tool can use to control itself or control other programs and devices. As a rule, generalized hardware (IBM and VAX) can support more languages than specific hardware (e.g., LISP machines). (The term LISP is used generically to refer to all LISP dialects.)

Procedural attachment refers to the capability to access external programs, data, hardware, and so on.

OTHER EXPERT SYSTEM DEVELOPMENT TOOL CHARACTERISTICS

The items below comprise the remainder of the items in the ESD tool survey. They are not features, but, are of interest to potential tool users.

Support

Availability indicates the probable availability of the tools. Research and experimental tools generally are not available, although there are some exceptions. A few institutions indicate that their ESD tools are available for a nominal charge.

Cost is the average cost of software and support (if available) at the end of 1986. Obviously, cost is subject to change. Some tools have different prices for commercial, government, and educational buyers. Separate source and object code prices are given for those vendors who supplied them. Cost is stated in dollars unless otherwise noted.

Modifiable/defeatable features represent the ability not to use certain features (e.g., forward chaining). Most tools explicitly or implicitly allow this to be done even though it is not usually stated as such.

Vendor support applies to commercial systems only. Most tools have some form of documentation. Only those vendors that offer services (training, consulting, etc.) beyond the documentation are indicated in the survey.

System Requirements

Hardware is the kind of computers that an ESD tool runs on. IBM PCs includes the PC, XT, or AT computers and compatibles unless stated otherwise.

Software indicates the programs (other than the tool itself) and operating systems that are necessary to use the tool. DOS stands for MS-DOS and PC-DOS.

Constraints

These are additional factors that constrain the usability of the system.

Rules/K are the approximate number of rules and/or facts that can be handled in a given amount of memory (K=1000 bytes of memory).

Expertise is an esitmate of the level of expertise that a novice tool user or system developer probably needs to have to develop an expert system with a given tool. Expertise is a combination of the user's experience with computers and the amount of effort required to learn the use of a particular tool. Regardless of all vendors claims about the easy-to-use PC-based systems, even a novice expert system developer should be computer savvy and possess minimal programming skills.

Typical Applications

General and specific applications are listed for some tools. Most tools are not restricted to a given problem or domain.

Other

This category is for miscellaneous comments about given tools, such as the minimum amount of memory.

Author/Vendor

This category refers to the commercial or institutional source of the tools, including address when possible.

Reference

The numbers under this category correspond to the numbers in the reference list and, therefore, indicate the source from which the information about a particular tool is taken. PC, under this heading only, stands for personal communication from one or more tool users.

INDEX TO THE ESD TOOL SURVEY

Table 1 is an index to the tools in Appendix B. It references the tools by four features that are important in evaluating, comparing, and selecting tools. They are Representation Method [rule (r), object/frame (o), network (n), and miscellaneous (m)], Chaining [forward (f), backward (b), or none (n)], Commercial Availability, and Personal Computer (PC) Version availability. No entry under Chaining means that the method was not stated in any of the sources. Page refers to the page in Appendix B where the tool can be found.

CONCLUSION

There are a large number of tools currently available and new tools are continually being developed. This survey is intended to provide a quick reference to a fair amount of these tools and should provide a starting point for comparisons and evalutions of ESD tools for a particular project.

TABLE 1

Index to Expert System Development Tools in Appendix B

Tool	Page	Representation Method[a]				Chaining Method[a]		Commercial Product	PC Version
ABEST	2	r						x	x
ACORN	2	r	o			f	b	x	x
ADS/MVS	2							x	
ADVISE	4	r		n	m	f	b		
AESDP	4	r	o				b	x	x
AGE	4	r				f	b		
AIMDS	6	r	o			f	b		
AL/X	6	r	o	n		f	b	x	x
AMORD	6	r		n		f			
APES	8	r		n	m		b	x	x
APLICOT	8	r			m	f	b		
ARBY	8	r			m		b		
ARS	10	r		n	m	f			
ART	10	r	o		m	f	b	x	
CONCHE	10	r		n			b		
CSRL	12	r		n					
DETEKTER	12	r	o						
DPL	12		o						
DUCK	14	r		n	m	f	b	x	
EMYCIN	14	r				n	b		
ERS	14	r		n					x
ESE/MVS	16	r	o			f	b	x	
ESIE	16	r					b	x	x
ES/P Ad.	16	r					b	x	x
ETS	18	r						x	.
ExperOPS5	18	r	o			f	n	x	x
EXPERT	18		o			f	b		
EXPERT-2	20	r					b		x
Expert-E.	20		o		m	n	n	x	x
EXPRS	20	r	o			f	b		
EXSYS	22	r	o			f	b	x	x
Ex-Tran7	22	r						x	x
FLOPS	22	r				f	b	x	x
FRL	24	r							
GEN-X	24	r	o		m				x
GEST	24	r	o			£	b	x	
GESBT 4.0	62	r	o		m	f	b	x	x
GETREE	26	r			m	f	b		
GLIB	26	r							
GPSI	26		o						
GUESS/1	28	r	o	n	m	f	b		
GURU	28	r			m	f	b	x	x
Hearsay-3	28	r							
HPRL	30	r	o			f	b		
IN-ATE/KE	30	r	o					x	x
INSIGHT-2	30	r				f	b	x	x
KAS	32	r		n		f	b		
K:base	32		o					x	x

[a] See text for an explanation of the codes.

TABLE 1 (Continued)

Index to Expert System Development Tools in Appendix B

Tool	Page	Representation Method[a]				Chaining Method[a]			Commercial Product	PC Version
		r	o	n	m	f	n	b		
KBS	32		o							
KDS 2	34	r				f		b	x	x
KEE	34	r	o	n	m	f		b	x	
KES	34	r	o				n	b	x	x
KL-1 & 2	36		o	n						
KMS	36	r	o					b		
Know. Cr.	36	r	o	n	m	f		b	x	
KNOWOL+	38	r	o			f		b	x	x
KRYPTON	38		o		m					
LES	38	r	o		m	f		b		
LOOPS	40	r	o		m	f		b	x	
M.1	40	r	o			f		b	x	x
MARS	40	r				f		b		
MELD	42	r	o		m	f		b		
MICE	42	r	o	n		f		b	x	x
MicroExp.	42	r		n					x	x
MORE	44	r								
MRS	44	r			m	f		b		
NETL	44		o	n						
NEXPERT	46	r				f		b	x	x
OPS5	46	r	o			f	n		x	
OPS5+	46	r	o			f	n		x	x
OPS83	48	r	o			f		b	x	x
OWL	48		o	n						
PC+	48		o	n		f		b	x	x
PICON	50	r	o			f		b	x	
PIE	50	r								
PLUME	50	r	o						x	
PRISM	52	r							x	
PSYCO	52	r	o	n		f				
RITA	52	r				f		b		
RLL	54		o							
ROGET	54	r				f		b		
ROSIE	54	r	o			f		b		
RuleMast.	56	r	o		m	f		b		
S.1	56	r	o				n	b	x	
SAGE	56	r				f		b	x	
SAVIOR	58	r			m	f		b	x	
SMALL-X	58	r				f		b	x	x
Teiresias	58		o							
TIMM	60	r	o		m	f	n		x	x
TOPSI	60	r							x	x
UNITS	60	r	o	n					x	
VIE-PCX	62	r	o						x	x
Xsys-II	62	r	o			f		b	x	x

REFERENCES

1. Bobrow, D. G., Mittal, S., & Stefik, M. J. (1986). Expert systems:
    Perils and promise. Communications of the ACM, 29, 880-894.

2. Brachman, R. J., & Schmolze, J. G. (1985). An overview of the KL-ONE
    knowledge representation system. Cognitive Science, 9, 171-202.

3. Bundy, A. (1984). Catalogue of artificial intelligence tools. New
    York: Springer-Verlag.

4. Bylander, T., & Mittal, S. (1986). CSRL: A language for classifica-
    tory problem solving. AI Magazine, 7 (3), 66-77.

5. Charniak, E., & McDermott, D. (1985). Introduction Artificial
    Intelligence. Reading, MA: Addison-Wesley.

6. Cromarty, A. S. (1985). What are current expert system tools missing?
    COMPCON Spring 85: 30th IEEE Computer Society International
    Conference: Technological Leverage: A competitive necessity,
    (pp. 411-418).

7. Harmon, P., & King, D. (1985). Expert systems: Artificial intelli-
    gence in business. New York: John Wiley & Sons.

8. Fox, M. S., Wright, J. M., & Adam, D. (1985). Experiences with SRL:
    An analysis of frame-based knowledge representation
    (CMU-RI-TR-85-10). Pittsburgh, PA: The Robotics Institute,
    Carnegie-Mellon University.

9. Kline, P. J., & Dolins, S. B. (1985). Choosing architectures for
    expert systems (RADC-TR-85-192). Griffiss Air Force Base, NY:
    Rome Air Development Center, Air Force Systems Command.

10. Lehner, P. E., & Barth, S. W. (1985). Expert systems on microcom-
    puters. Expert Systems, 2, 198-208.

11. Richer, M. H. (1986). An evaluation to expert system development
    tools. Expert Systems, 3, 166-183.

12. Science Applications International Corporation. (1986). Generic Expert
    System Building Tool Version 4.0, Author.

13. Staff. (1985). Directory of microcomputer-based software for expert
    systems work. Expert Systems, 2, 222-228.

14. Staff. (1986). New product announcements (vol. 7). AI Magazine.

15. Staff. (1986, May 19). Special report: 16 expert systems tools
    detailed. Advanced Military Computing, 2 (10), 4-6.

16. Waterman, D. A. (1986). A guide to expert systems. Reading, MA:
    Addison-Wesley.

17. Winston, P. H. (1984). Artificial intelligence (2nd ed.). Reading,
    MA: Addison-Wesley.

18. Xerox. (1986). Xerox LOOPS: Object oriented programming for knowledge
    engineering, Author.

APPENDIX A

Expert System Tools Included in the Survey

APPENDIX A

Expert System Tools Included in the Survey

1. ABEST (Ada-Based Expert System Tool)
2. ACORN
3. ADS/MVS (Aion Development System/MVS)
4. ADVISE
5. AESDP (Arity Expert System Development Package)
6. AGE (Attempt to GEneralize)
7. AIMDS
8. AL/X (Advice Language/X)
9. AMORD (A Miracle Of Rare Device)
10. APES (A Prolog Expert system Shell)
11. APLICOT
12. ARBY
13. ARS
14. ART (Automated Reasoning Tool)
15. CONCHE (CONsistency CHEcker)
16. CSRL (Conceptual Structures Representation Language)
17. DETEKTER (Development Environment for TEKtronics TRoubleshooters)
18. DPL (Design Procedure Language)
19. DUCK
20. EMYCIN (Essential MYCIN)
21. ERS (EObedded Rule-based System)
22. ESE/MVS (Expert System Environment/MVS)
23. ESIE
24. ES/P Advisor (Expert System/Prolog)
25. ETS (Expertise Transfer System)
26. ExperOPS5 (A version of OPS5)
27. EXPERT
28. EXPERT-2
29. Expert-Ease [A version of ACLS (Analog Concept Learning System)]
30. EXPRS (EXpert PRolog System)
31. EXSYS
32. Ex-Tran7
33. FLOPS
34. FRL (Frame Representation Language)
35. GEN-X (GENeric-eXpert system)
36. GEST (Generic Expert System Tool)
37. GETREE
38. GLIB (General Language for Instrument Behavior)
39. GPSI (General Purpose System for Inferencing)
40. GUESS/1 (General pUrpose Expert Systems Shell)
41. GURU
42. Hearsay-III
43. HPRL (Heuristic Programming and Representation Language)
44. IN-ATE/KE (INtelligent-Automatic Test Equipment/Knowledge Engineering)
45. INSIGHT-2
46. KAS (Knowledge Acquisition System)

Expert System Tools Incuded in the Survey

47. K:base
48. KBS (Knowledge-Based Simulation system)
49. KDS 2
50. KEE (Knowledge Engineering Environment)
51. KES (Knowledge Engineering System)
52. KL-ONE and KL-TWO
53. KMS (Knowledge Management System)
54. Knowledge Craft
55. KNOWOL+
56. KRYPTON
57. LES (Lockheed Expert System)
58. LOOPS (Lisp Object-Oriented Programming System)
59. M.1
60. MARS (Multiple Abstraction Rule-based System)
61. MELD (MEta-Level Diagnosis)
62. MICE
63. MicroExpert
64. MORE
65. MRS (Metalevel Representation System)
66. NETL
67. NEXPERT
68. OPS5
69. OPS5+
70. OPS83
71. OWL
72. PC+ (Personal Consultant Plus)
73. PICON (Process Intelligent CONtrol system)
74. PIE (Personal Information Environment)
75. PLUME
76. PRISM (PRototype Inference SysteM)
77. PSYCO (Production SYstem COmpiler)
78. RITA (Rand Intelligent Terminal Agent)
79. RLL (Representation Language Language)
80. ROGET
81. ROSIE (Rule-Oriented System for Implementing Expertise)
82. RuleMaster
83. S.1 (System.1)
84. SAGE
85. SAVIOR
86. SMALL-X
87. Teiresias
88. TIMM and TIMM-PC (The Intelligent Machine Model)
89. TOPSI (A version of OPS5)
90. UNITS
91. VIE-PCX
92. Xsys-II
93. GESBT 4.0 (Generic Expert System Building Tool)

APPENDIX B

Expert System Development Tools

Expert System Development Tools. The tools are arranged alphabetically.
See Appendix A for tool names.

TOOL FEATURES	ABEST	ACORN	ADS/MVS
Knowledge Representation:			
access-based			
decision tree			
hierarchy			
logic-based			
networks			
objects/classes/frames		X	
procedures/rules	X	X	
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms	X		
blackboard			
chaining/rule application:			
backward		X	
forward		X	
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values			
inheritance			
meta-reasoning			
pattern matching			
Problem solving:			
classification			
conflict resolution	X		
resolution			
Search methods:			
backtracking:			
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:			
Fuzzy logic/sets			
Probabilistic:			
Bayes'			
confidence factors			
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	ABEST	ACORN	ADS/MVS
Knowledge acquisition:			
conflict detection			
explicit rule entry			
fact/control knowledge			
knowledge base editor	X		X
rules induced from examples			
User Interface			
command language			
debugging aids - trace/help			
explanation/history			
forms/reports			X
graphics/graphic primitives			X
menus/prompts			
mouse			
restricted natural language			
voice			
windows			X
External Access:			
data bases		X	X
languages	ADA	X	
procedural attachment		X	X
spreadsheets		X	
other packages			
Usability:			
availability	Commercial	Commercial	Commercial
cost	O=25K, S=50K*	5K	60K
modifiable/defeatable			
vendor support		5	
System Requirements:			
hardware	IBM-AT, VAX,	IBM-AT	IBM370
software/operating system	Symbolics		IBM Graphic Packages
Constraints:			
# rules/xK of memory			
developer expertise	High	Medium	High
Typical application(s):			
Other:	Made for ADA		
	Environment		
Author/vendor:	Gilmore Aerospace	Gold Hill Computers	Aion Corp.
	Atlanta	(800) 242-LISP	(415) 328-9595
Reference(s):	14	14	14

* S=Source code; O=Object code; K = $ in thousands.

TOOL FEATURES	ADVISE	AESDP	AGE
Knowledge Representation:			
access-based			
decision tree			
hierarchy	X	X	
logic-based			
networks	Semantic		
objects/classes/frames		X	X
procedures/rules			
spreadsheet(s)/data base(s)	Relational DB		
Control & Inference Mechanisms:			
agenda mechanism			
algorithms			
blackboard		X	
chaining/rule application:			
backward	X	X	X
forward	X		X
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values			
inheritance			
meta-reasoning			
pattern matching			
Problem solving:			
classification	X		
conflict resolution			
resolution			
Search methods:			
backtracking:			
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax	X		
shallow			
time-dependent			
truth maintenance system			
Certainty Management:			
Fuzzy logic/sets			
Probabilistic:			
Bayesian	X		
confidence factors	Weighted		
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	ADVISE	AESDP	AGE
Knowledge acquisition:			
conflict detection			
explicit rule entry			
fact/control knowledge			
knowledge base editor			
rules induced from examples	X		
User Interface			
command language			
debugging aids - trace/help			Trace
explanation/history	Expl.	Expl.	History
forms/reports			
graphics/graphic primitives			
menus/prompts			
mouse			
restricted natural language			
voice			
windows			
External Access:			
data bases			
languages	Pascal	Prolog	LISP
procedural attachment		X	
spreadsheets			
other packages			
Usability:			
availability	Research	Commerical	Research
cost		295	
modifiable/defeatable			
vendor support			
System Requirements:			
hardware	VAX	IBM PCs & Com*	Xerox 1100&DEC-10,20
software/operating system	UNIX		
Constraints:			
# rules/xK of memory			
developer expertise	High	Medium	High
Typical application(s):			
Other:			Graphics Interface for Xerox 1100s
Author/vendor:	Univ. of Illinois	Arity Corp. 358 Baker Ave. Concord, MA 01742	Stanford Univ.
Reference(s):	16	14	16

*PCs = PC, XT, & AT; Com = IBM Compatible;

TOOL FEATURES	AIMDS	AL/X	AMORD
Knowledge Representation:			
access-based			
decision tree			
hierarchy			
logic-based			
networks		Semantic	Discrimination
objects/classes/frames	X	X	
procedures/rules	X	X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms			
blackboard			
chaining/rule application:			
backward	X	X	
forward	X	X	X
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values	X		
inheritance			
meta-reasoning			
pattern matching			
Problem solving:			
classification			
conflict resolution			
resolution			
Search methods:			
backtracking:			
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			X
Certainty Management:			
Fuzzy logic/sets			
Probabilistic:			
Bayesian		X	
confidence factors			
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds	X		
Model directed	X		
Multiple/alternative DB's			
Multiple Lines of Reasoning	Belief Contexts		

TOOL FEATURES	AIMDS	AL/X	AMORD
Knowledge acquisition:			
conflict detection	X		
explicit rule entry			
fact/control knowledge			
knowledge base editor			
rules induced from examples			
User Interface			
command language			
debugging aids - trace/help			
explanation/history		Expl.	Expl.
forms/reports			
graphics/graphic primitives			
menus/prompts		X	
mouse			
restricted natural language			
voice			
windows			
External Access:			
data bases			
languages	LISP, Fuzzy	Pascal	LISP
procedural attachment	X		
spreadsheets			
other packages			
Usability:			
availability	Research	Commercial	Research
cost			
modifiable/defeatable			
vendor support			
System Requirements:			
hardware		Apple II, IBM PCs, LSI-11/02, PDP-11/34	
software/operating system		UCSD Pascal, UNIX, DOS	
Constraints:			
# rules/xK of memory		100/64	
developer expertise	High	Medium	High
Typical application(s):		Diagnose Oil Platform Shutdowns	
Other:	Fuzzy is a LISP-based language	64K RAM on Apple	
Author/vendor:	Rutgers Univ.	Intelignt Tmnls Ltd 15 Canal Street Oxford OX2 6BH, Eng.	Mass. Institute of Technology*
Reference(s):	16	10, 16	16

* Called MIT from here on.

TOOL FEATURES	APES	APLICOT	ARBY
Knowledge Representation:			
access-based			
decision tree			
hierarchy			
logic-based	X	X	X
networks	Causal		
objects/classes/frames			
procedures/rules	X	X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms			
blackboard			
chaining/rule application:			
backward	X	X	X
forward		X	
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values			
inheritance			
meta-reasoning			
pattern matching			
Problem solving:			
classification			
conflict resolution			
resolution			
Search methods:			
backtracking:	X		
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:		X	
Fuzzy logic/sets			
Probabilistic:			
Bayesian	X		
confidence factors	User Specified		
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	APES	APLICOT	ARBY
Knowledge acquisition:			
conflict detection			
explicit rule entry			
fact/control knowledge			
knowledge base editor		X	X
rules induced from examples			
User Interface			
command language			
debugging aids - trace/help			
explanation/history	Expl.	Expl.	Expl.
forms/reports			
graphics/graphic primitives			
menus/prompts			
mouse			
restricted natural language			
voice			
windows			
External Access:			
data bases			
languages	Prolog	Prolog	Prolog
procedural attachment			
spreadsheets			
other packages			
Usability:			
availability	Commercial	Experimental	Research
cost	395*		
modifiable/defeatable			
vendor support			
System Requirements:			
hardware	IBM PCs & Com	DEC-10	VAX, Apollo, Symblcs
software/operating system	DOS, CPM86, UNIX, Micro Prolog	Prolog	DUCK
Constraints:			
# rules/xK of memory	400/128		
developer expertise	Medium, High	High	High
Typical application(s):	Diagnosis, Planning		Diagnose fault isolation & distributed inventory network.
Other:			DUCK is an expert system tool.
Author/vendor:	Logic Based Sys.Ltd. 40 Beaumont Ave. Richmond Surrey TW9 2HE, Eng.	Univ. of Tokyo	Yale Univeristy
Reference(s):	10, 13, 16	16	16

* Pounds

TOOL FEATURES	ARS	ART	CONCHE
Knowledge Representation:			
access-based	X	None	
decision tree			
hierarchy		X	
logic-based		X	
networks	Associative		Semantic
objects/classes/frames		X	
procedures/rules	X	X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms		X	
blackboard			
chaining/rule application:			
backward		X	X
forward	X	X	
parallel			
recursive/nested			
sequential/rule order			
constraint propagation		X	
default values		X	
inheritance		X	
meta-reasoning		X	
pattern matching	X	X	
Problem solving:			
classification			
conflict resolution	X	X	
resolution			
Search methods:			
backtracking:			
chronological		X	
dependency directed	X		
breadth first		X	
opportunistic		X	
pruning:			
minimax			
shallow			
time-dependent		X	
truth maintenance system		X	
Certainty Management:			
Fuzzy logic/sets			
Probabilistic:			
Bayesian			
confidence factors		X	X
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds		Viewpoints	
Model directed		X	
Multiple/alternative DB's			
Multiple Lines of Reasoning		X	

TOOL FEATURES	ARS	ART	CONCHE
Knowledge acquisition:		None	
conflict detection			
explicit rule entry			
fact/control knowledge			
knowledge base editor		X	
rules induced from examples			
User Interface			
command language		X	
debugging aids - trace/help		X	
explanation/history	History	X	Expl.
forms/reports			
graphics/graphic primitives		ARTIST	
menus/prompts		X	
mouse		X	
restricted natural language			
voice			
windows		X	
External Access:			
data bases		X	
languages	LISP	C, LISP	LISP
procedural attachment		X	
spreadsheets			
other packages			
Usability:			
availability	Research	Commerical	Research
cost		Univ.5K/Bus.85K	
modifiable/defeatable		X	
vendor support		X	
System Requirements:			
hardware		VAX, LMI, Lambda	VAX, IBM, RT, LMI
		TI Explorer,	Symbolics, TI, SUN
		Symbolics	Apollo
software/operating system	MULTICS, ITS, or TOPS-10	ARTIST	
Constraints:			
# rules/xK of memory			
developer expertise	High	High	Medium
Typical application(s):		General purpose	Organic
		interpretation	reactions
		and diagnosis	
Other:		Artist is graphics	
		package	
Author/vendor:	MIT	Interface Corp.	Univ. of Leeds
		5300 W.Century Blvd.	
		Los Angeles,CA 90045	
Reference(s):	15	7, 11, 15, 16	16

TOOL FEATURES	CSRL	DETEKTER	DPL
Knowledge Representation:			
access-based			
decision tree			
hierarchy	X	X	
logic-based			
networks			
objects/classes/frames	X	X	X
procedures/rules	X	X	
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms			
blackboard			
chaining/rule application:			
backward			
forward			
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values			
inheritance			
meta-reasoning			
pattern matching	X		
Problem solving:			
classification	X		
conflict resolution			
resolution			
Search methods:			
backtracking:			
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:			
Fuzzy logic/sets			
Probabilistic:			
Bayesian			
confidence factors	X		
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	CSRL	DETEKTR	DPL
Knowledge acquisition:			
conflict detection			
explicit rule entry	X		X
fact/control knowledge			
knowledge base editor	X		
rules induced from examples			
User Interface			
command language			
debugging aids - trace/help	Trace		
explanation/history		Expl.	
forms/reports			
graphics/graphic primitives			Graphics
menus/prompts			
mouse	X		
restricted natural language		X	
voice			
windows			
External Access:			
data bases			
languages	LISP, LOOPS	SMALLTALK-80	LISP
procedural attachment	X		
spreadsheets			
other packages			
Usability:			
availability	Research	Experimental	Research
cost			
modifiable/defeatable			
vendor support			
System Requirements:			
hardware	DEC-20, 60	Tektronix 4404	Symbolics
software/operating system			
Constraints:			
# rules/xK of memory			
developer expertise	High	Low	High
Typical application(s):	Diagnosis	Troubleshooting	LSI Design, Simulation
Other:			
Author/vendor:	Laboratory for AI Research Ohio State Univ. Colubus, OH 43210	Tektronix, Inc. Computer Resrch.Lab. P.O. Box 500 Beaverton, OR 97077	MIT
Reference(s):	4, 15	16	16

APPENDIX B

TOOL FEATURES	DUCK	EMYCIN	ERS
Knowledge Representation:			
access-based			
decision tree			
hierarchy			X
logic-based	X		
networks	Causal		Semantic
objects/classes/frames	X	X	X
procedures/rules			
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms			
blackboard			
chaining/rule application:			
backward	X	X	
forward	X	None	
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values			
inheritance			
meta-reasoning			
pattern matching			
Problem solving:			
classification			
conflict resolution		X	
resolution		None	
Search methods:			
backtracking:			
chronological			
dependency directed	X		
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system	X		
Certainty Management:			
Fuzzy logic/sets			X
Probabilistic:			
Bayesian			X
confidence factors		X	
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	DUCK	EMYCIN	ERS
Knowledge acquisition:		X	
conflict detection		X	
explicit rule entry			
fact/control knowledge			
knowledge base editor			
rules induced from examples			
User Interface			
command language			
debugging aids - trace/help			
explanation/history		Expl.	Expl.
forms/reports			
graphics/graphic primitives			Graphics
menus/prompts			X
mouse			
restricted natural language		X	
voice			
windows			
External Access:			
data bases			X
languages	LISP	LISP	Pascal
procedural attachment		X	
spreadsheets			
other packages			
Usability:			
availability	Commercial	Research	Research
cost			
modifiable/defeatable			
vendor support			
System Requirements:			
hardware	VAX, Symbolics,	DEC-10	IBM PCs, VAX
software/operating system	UNIX, VMS		
Constraints:			
# rules/xK of memory			
developer expertise	Medium-High	Medium-High	
Typical application(s):		Diagnosis, Classification	Signal Classification, Design Evaluation
Other:			256K RAM
Author/vendor:	Smart Systems Tech. Suite 421 North 770 Leesburg Place Fls.Church,VA 22034		PAR Technology Corp. 220 Seneca Turnpike New Hartford, NY 13413
Reference(s):	16	6, 7, 16	10, 16

TOOL FEATURES	ESE/MVS	ESIE	ES/P Advisor
Knowledge Representation:			
access-based			
decision tree			
hierarchy			
logic-based			
networks			
objects/classes/frames	X		
procedures/rules	X	X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms			
blackboard			
chaining/rule application:			
backward	X	X	X
forward	X		
parallel			
recursive/nested			
sequential/rule order			X
constraint propagation			
default values			
inheritance			Limited
meta-reasoning			
pattern matching			
Problem solving:			
classification			
conflict resolution			
resolution			X
Search methods:			
backtracking:			
chronological			Limited
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:	X		None
Fuzzy logic/sets			
Probabilistic:			
Bayesian			
confidence factors			
	None		
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	ESE/MVS	ESIE	ES/P Advisor
Knowledge acquisition:	None		
conflict detection	X	Legal Values	
explicit rule entry			
fact/control knowledge			
knowledge base editor	X		
rules induced from examples			
User Interface			
command language			
debugging aids - trace/help	X	Trace	
explanation/history	Expl.		Expl.
forms/reports			
graphics/graphic primitives			
menus/prompts			X
mouse			
restricted natural language			
voice			
windows			
External Access:			
data bases			
languages	Pascal, Others		Prolog
procedural attachment	X		X
spreadsheets			
other packages			
Usability:			
availability	Commercial	Commercial	Commercial
cost	35K	145	1895
modifiable/defeatable			
vendor support		X	
System Requirements:			
hardware	IBM 370	IBM PCs & Com	IBM PCs
software/operating system	MVS; Time Sharing & Graphics Options Pascal	DOS	DOS
Constraints:			
# rules/xK of memory			
developer expertise	High	Low-Medium	Medium
Typical application(s):			Prediction, Planning, Diagnosis
Other:	Can be rented for $1750 Mo.	128K RAM	128K RAM and Color Monitor
Author/vendor:	IBM Info. Services Menlo Park, CA	Lightware Consultns. PO Box 290539 Tampa, FL 33617	Expert Systms. Intl. 1150 First Avenue King of Prussia, PA 19406
Reference(s):	14, 15	14	7, 13, 14

TOOL FEATURES	ETS	ExperOPS5	EXPERT
Knowledge Representation:			
access-based			
decision tree			
hierarchy			
logic-based			
networks			
objects/classes/frames		Limited	X
procedures/rules	X	X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms			
blackboard		X	
chaining/rule application:			
backward		None	X
forward		X	Limited
parallel			
recursive/nested			
sequential/rule order			X
constraint propagation			
default values			
inheritance			
meta-reasoning		Limited	
pattern matching		X	
Problem solving:			X
classification			
conflict resolution		X	
resolution		None	
Search methods:			
backtracking:			
chronological		Limited	
dependency directed			
breadth first		Limited	
opportunistic			
pruning:			
minimax			
shallow			
time-dependent		Time Tags	
truth maintenance system			
Certainty Management:			
Fuzzy logic/sets			
Probabilistic:			
Bayesian			
confidence factors	X		X
Hypothesis handling:		None	
Group & differentiate			
Hypothetical worlds			X
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	ETS	ExperOPS5	EXPERT
Knowledge acquisition:		None	Rulewriter
conflict detection			X
explicit rule entry			
fact/control knowledge			
knowledge base editor	X	Limited	SEEK
rules induced from examples	X		X
User Interface			
command language			
debugging aids - trace/help		X	Trace
explanation/history		History	Expl.
forms/reports			
graphics/graphic primitives		Graphics	
menus/prompts			
mouse			
restricted natural language		None	X
voice			
windows		X	
External Access:			
data bases			
languages	LISP	BLISS, LISP	FORTRAN, LISP
procedural attachment			
spreadsheets			
other packages			
Usability:			
availability	Commerical	Commerical	Research
cost		325	
modifiable/defeatable			
vendor support			
System Requirements:			
hardware	Xerox 1100s	MacIntosh 512K	DEC, IBM
software/operating system		ExperLISP	Rulewriter, SEEK
Constraints:			
# rules/xK of memory			
developer expertise	Medium-High	Low-Medium	Low
Typical application(s):	Construct & Analyze OPS5 Data Bases		Diagnosis, Classification
Other:		Equivalent to OPS5.	Must use SEEK & Rulewriter for knowledge acquisition.
Author/vendor:	Boeing Cmpter. Serv. AI Center PO Box 24346 Seattle, WA 98124	ExperTelligence,Inc. 559 San Ysidro Rd. Santa Barbara, CA 93108	Weiss & Kulikowski Dept. of Cmpter. Sci. Rutgers University New Brunswick, NJ 08903
Reference(s):	16	13	7, 16

APPENDIX B

TOOL FEATURES	EXPERT-2	Expert-Ease	EXPRS
Knowledge Representation:			
access-based			
decision tree		Matrix	
hierarchy		None	
logic-based			
networks			
objects/classes/frames		None	X
procedures/rules	X		X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms		X	
blackboard			
chaining/rule application:			
backward	X	None	X
forward		None	
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values			
inheritance			
meta-reasoning			
pattern matching			
Problem solving:			
classification		X	
conflict resolution			
resolution			
Search methods:			
backtracking:			
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:		None	
Fuzzy logic/sets			
Probabilistic:			
Bayesian			
confidence factors			
Hypothesis handling:		None	
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	EXPERT-2	Expert-Ease	EXPRS
Knowledge acquisition:			
conflict detection			
explicit rule entry			
fact/control knowledge			
knowledge base editor		X	
rules induced from examples		X	
User Interface			
command language			
debugging aids - trace/help			
explanation/history		Expl.	Expl.
forms/reports			
graphics/graphic primitives			
menus/prompts		X	
mouse			
restricted natural language			X
voice			
windows			
External Access:			
data bases		X	
languages	FORTH	Pascal	Prolog
procedural attachment			
spreadsheets		X	
other packages			
Usability:			
availability	Experimental	Commercial	Research
cost		2K	
modifiable/defeatable			
vendor support			
System Requirements:			
hardware	Apple II	Apple IIs,	DEC-10
		IBM PCs & Com,	
		DEC Rainbow,	
		UCSD P-System	
software/operating system			
Constraints:			
# rules/xK of memory			
developer expertise	Medium-High	Low	High
Typical application(s):		Induce game rules and moves.	
Other:		Upgraded ACLS	
Author/vendor:	Helin, Inc.	Jeffrey Perrone & Associates 3685 17th Street San Francisco, CA	Lockheed Palo Alto Research Labs. 3251 Hanover Street Palo Alto, CA 94304
Reference(s):	16	7, 10, 13, 15, 16	16

TOOL FEATURES	EXSYS	Ex-Tran7	FLOPS
Knowledge Representation:			
access-based			
decision tree			
hierarchy	X		
logic-based			
networks			
objects/classes/frames	X		
procedures/rules	X	X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms			
blackboard			X
chaining/rule application:			
backward	X		X
forward	X		X
parallel			X
recursive/nested			
sequential/rule order			X
constraint propagation			
default values			
inheritance			
meta-reasoning			
pattern matching			
Problem solving:			
classification			
conflict resolution			X
resolution			
Search methods:			
backtracking:			X
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			Time Tags
truth maintenance system			Fuzzy
Certainty Management:			
Fuzzy logic/sets			X
Probabilistic:			
Bayesian			
confidence factors			X
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	EXSYS	ExTran7	FLuPS
Knowledge acquisition:			
conflict detection			
explicit rule entry		X	
fact/control knowledge			
knowledge base editor			
rules induced from examples		X	
User Interface			
command language	Algebraic		
debugging aids - trace/help	Trace		
explanation/history		Expl.	
forms/reports	X		
graphics/graphic primitives			
menus/prompts	X		
mouse			
restricted natural language	X		
voice			
windows			
External Access:			
data bases	X		
languages	C, LISP	FORTRAN	
procedural attachment	X		X
spreadsheets			
other packages			
Usability:			
availability	Commerical	Commerical	Commerical
cost	1K	1995 *	495
modifiable/defeatable			
vendor support	X		
System Requirements:			
hardware	IBM PCs & Com, VAX, MacIntosh	IBM PCs, Grid PC	IBM PCs & Com
software/operating system			DOS
Constraints:			
# rules/xK of memory	5000/640		
developer expertise	Medium	Low-Medium	Low-Medium
Typical application(s):			Image Analysis, Signal Classification
Other:		512K RAM + math coprocessor.	256K RAM, math co-processor optional.
Author/vendor:	EXSYS, Inc/ PO Box 75158 Albuquerque, NM 87194	Intelligent Termnls. Ltd. 15 Canal Street Oxford OX2 6BH England	Dr. W. Siler Kemp-Carraway Heart Institute 1600 N. 26th Street Birmingham, AL 35234
Reference(s):	13, 14	13	14

* Pounds

TOOL FEATURES	FRL	GEN-X	GEST
Knowledge Representation:			
access-based			
decision tree		Tables	
hierarchy			
logic-based			
networks			
objects/classes/frames	X	X	X
procedures/rules		X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			X
algorithms			
blackboard			X
chaining/rule application:			
backward			X
forward			X
parallel			
recursive/nested			
sequential/rule order			
constraint propagation	X		
default values	X		
inheritance	Multiple	X	
meta-reasoning			
pattern matching			
Problem solving:			
classification			
conflict resolution			X
resolution			
Search methods:			
backtracking:			
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:			
Fuzzy logic/sets			
Probabilistic:			
Bayesian			
confidence factors			
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	FRL	GEN-X	GEST
Knowledge acquisition:			
conflict detection			
explicit rule entry			
fact/control knowledge			
knowledge base editor		Graphical	
rules induced from examples			
User Interface			
command language			
debugging aids - trace/help			
explanation/history			Expl.
forms/reports			
graphics/graphic primitives		Color	
menus/prompts			
mouse			
restricted natural language			
voice			
windows			
External Acces :			
data bases			
languages	LISP	C,FORTRAN,Pascal,ADA	
procedural attachment	X		
spreadsheets			
other packages			
Usability:			
availability	Experimental	Research	Commercial
cost			O=15K, S=45K
modifiable/defeatable			
vendor support			
System Requirements:			
hardware		LSI-11s, IBM PCs, PDP-11/23	TI Explorer, VAX, Symbolics
software/operating system			
Constraints:			
# rules/xK of memory		1000/256	
developer expertise	High	High	High
Typical application(s):		Troubleshooting jet engines, process control.	
Other:			
Author/vendor:	MIT	General Electric R & D Center 1 River Road Schenectady,NY 12345	Georgia Tech Atlanta, GA
Reference(s):	16	10, 16	14

TOOL FEATURES	GETREE	GLIB	GPSI
Knowledge Representation:			
access-based			
decision tree	X		
hierarchy			
logic-based			
networks			
objects/classes/frames			X
procedures/rules	X	X	
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			Supervisor
algorithms			
blackboard			
chaining/rule application:			
backward	X		
forward	X		
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values			
inheritance			
meta-reasoning			
pattern matching			
Problem solving:			
classification			
conflict resolution			
resolution			
Search methods:			
backtracking:			
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
· shallow			
time-dependent			
truth maintenance system			
Certainty Management:			X
Fuzzy logic/sets			
Probabilistic:			
Bayesian			
confidence factors			
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	GETREE	GLIB	GPSI
Knowledge acquisition:		X	
conflict detection			
explicit rule entry			
fact/control knowledge			
knowledge base editor			X
rules induced from examples			
User Interface			
command language			
debugging aids - trace/help	X		X
explanation/history	Expl.	Expl.	Expl.
forms/reports			
graphics/graphic primitives	Graphics		Graphics
menus/prompts		X	
mouse			
restricted natural language		X	
voice	Output		
windows			
External Access:			
data bases			
languages		SMALLTALK-80	
procedural attachment			
spreadsheets			
other packages			
Usability:			
availability	Experimental	Research	Experimental
cost			
modifiable/defeatable			
vendor support			
System Requirements:			
hardware	VAX	Tektronix 4404	
software/operating system			
Constraints:			
# rules/xK of memory			
developer expertise	Low-Medium	High	Low-Medium
Typical application(s):		Electronics Diag.	
Other:			
Author/vendor:	General Electric	Tektronix, Inc.	Univ. of Illnois
	R&D Center	Computer Res. Labs.	
	1 River Road	PO Box 500	
	Schenectady, NY	Beaverton, OR	
	12345	97077	
Reference(s):	16	16	16

TOOL FEATURES	GUESS/1	GURU	Hearsay-III
Knowledge Representation:			
access-based			
decision tree			
hierarchy	Trees		
logic-based			
networks	Semantic		
objects/classes/frames	X		
procedures/rules	X	X	X
spreadsheet(s)/data base(s)	Relational Tables	X	
Control & Inference Mechanisms:			
agenda mechanism			
algorithms			
blackboard	X		X
chaining/rule application:			
backward	X	X	
forward	X	X	
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values			
inheritance			
meta-reasoning			
pattern matching		X	
Problem solving:			
classification			
conflict resolution			
resolution			
Search methods:			
backtracking:			
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:		X	
Fuzzy logic/sets			
Probabilistic:			
Bayesian			
confidence factors			
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	GUESS/1	GURU	Hearsay-III
Knowledge acquisition:			
conflict detection			
explicit rule entry			
fact/control knowledge			
knowledge base editor			
rules induced from examples			
User Interface			
command language		X	
debugging aids - trace/help			
explanation/history	Expl.		
forms/reports			
graphics/graphic primitives			
menus/prompts	X	X	
mouse			
restricted natural language	X	X	
voice			
windows		X	
External Access:			
data bases			
languages	Prolog		LISP
procedural attachment			
spreadsheets			
other packages		X	
Usability:			
availability	Research	Commerical	Research
cost			
modifiable/defeatable			
vendor support			
System Requirements:			
hardware	VAX	IBM PCs & Com	
software/operating system	VMS		
Constraints:			
# rules/xK of memory			
developer expertise	Medium-High	Low-Medium	High
Typical application(s):			Speech, Understanding, Design
Other:	Multilevel user security mechanism.	Customizable User Interfaces	
Author/vendor:	Computer Sci. Dept. Virginia Polytechnic Institute & State University	Micro Database Systems, Inc. PO Box 248 Lafayette, IN 47902	Information Sciences Institute 4676 Admiralty Way Marina del Ray, CA
Reference(s):	16	PC	16

TOOL FEATURES	HPRL	IN-ATE/KE	INSIGHT-2
Knowledge Representation:			
access-based			
decision tree			
hierarchy			X
logic-based			
networks			
objects/classes/frames	X	X	
procedures/rules	X	X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms			
blackboard			
chaining/rule application:			
backward	X		X
forward	X		Limited
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values			
inheritance			
meta-reasoning	X		
pattern matching			
Problem solving:			
classification			
conflict resolution			
resolution			
Search methods:			
backtracking:			
chronological			X
dependency directed			
breadth first			X
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:			
Fuzzy logic/sets			
Probabilistic:			User Defined
Bayesian			
confidence factors			X
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	HPRL	IN-ATE/KE	INSIGHT-2
Knowledge acquisition:			
conflict detection			
explicit rule entry			
fact/control knowledge			
knowledge base editor			
rules induced from examples		X	
User Interface			
command language			
debugging aids - trace/help			Trace
explanation/history			Expl.
forms/reports			
graphics/graphic primitives			
menus/prompts			X
mouse			
restricted natural language			X
voice			
windows			
External Access:			
data bases			X
languages	LISP	LISP, Pascal	Pascal
procedural attachment			X
spreadsheets			
other packages		Graphics	
Usability:			
availability	Research	Commerical	Commercial
cost		5K	485
modifiable/defeatable			
vendor support			X
System Requirements:			
hardware	VAX, HP	IBM PCs, DEC, Apple, Data General	DEC Rainbow, IBM PCs
software/operating system			
Constraints:			
# rules/xK of memory			400/256
developer expertise	High		Low-Medium
Typical application(s):		Fault diagnosis only	Diagnosis
Other:		Uses CAD & reliabil-ity test data as input. 512K RAM PC version called Micro IN/ATE	256K RAM Knowledge base hierarchies can have max of 48 levels with 32 goals/level.
Author/vendor:		Automated Reasoning Corp. 290 W. 12th Street Suite 1D New York, NY 10014	Level Five Research Inc. 4980 S. A-1-A Melbourne Beach, FL 32951
Reference(s):	16	13, 14, 16	7, 13

TOOL FEATURES	KAS	K:base	KBS
Knowledge Representation:			
access-based			
decision tree			
hierarchy			
logic-based			
networks	Semantic		
objects/classes/frames		X	X
procedures/rules			
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms			
blackboard			
chaining/rule application:			
backward	X		
forward	X		
parallel			
recursive/nested			
sequential/rule order			
constraint propagation	X		
default values			
inheritance			
meta-reasoning			
pattern matching			
Problem solving:			
classification			
conflict resolution			
resolution			
Search methods:			
backtracking:			
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:			
Fuzzy logic/sets			
Probabilistic:			
Bayesian			
confidence factors	X		
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	KAS	K:BASE	KBS
Knowledge acquisition:			
conflict detection		X	
explicit rule entry			
fact/control knowledge			
knowledge base editor	X	X	
rules induced from examples			
User Interface			
command language	X		
debugging aids - trace/help	Trace		
explanation/history	X		
forms/reports			
graphics/graphic primitives		Graphics	
menus/prompts			
mouse			
restricted natural language			
voice			
windows			
External Access:			
data bases			
languages	LISP	LISP	SRL, LISP
procedural attachment			
spreadsheets			
other packages			
Usability:			
availability	Research	Commercial	Experimental
cost			
modifiable/defeatable			
vendor support			
System Requirements:			
hardware		IBM PCs, Symbolics	VAX
software/operating system			
Constraints:			
# rules/xK of memory			
developer expertise	High	Medium	High
Typical application(s):		Interest Rate Anal.	Simulation
Other:		512K RAM on PCs	SRL is a LISP-based language.
Author/vendor:	SRI International 333 Ravenswood Ave. Menlo Park, CA 94025	Gold Hill Computers 163 Harvard Street Cambridge, MA 02139	Robotics Institute Carnegie-Mellon Univ.* Pittsburgh, PA 15213
Reference(s):	16	7, 10	16

*Referred to as CMU from here on.

APPENDIX B

TOOL FEATURES	KDS 2	KEE	KES
Knowledge Representation:			
access-based		X	
decision tree			
hierarchy			
logic-based		X	
networks			
objects/classes/frames		X	X
procedures/rules	X	X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms		X	X
blackboard			
chaining/rule application:			
backward	X	X	X
forward	X	X	None
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values		X	
inheritance		X	X
meta-reasoning			
pattern matching			
Problem solving:			
classification			X
conflict resolution		X	
resolution			
Search methods:			
backtracking:			
chronological		X	
dependency directed			
breadth first		X	
opportunistic			
pruning:			
minimax			
shallow			
time-dependent		X	
truth maintenance system			
Certainty Management:			
Fuzzy logic/sets			
Probabilistic:			
Bayesian			X
confidence factors	X	X	
Hypothesis handling:		None	
Group & differentiate			
Hypothetical worlds			X
Model directed			X
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	KDS2	KEE	KES
Knowledge acquisition:		None	X
conflict detection			
explicit rule entry			
fact/control knowledge			
knowledge base editor		X	None
rules induced from examples	X		
User Interface			
command language			
debugging aids - trace/help	Help	X	Trace
explanation/history	Expl.	X	Expl.
forms/reports			
graphics/graphic primitives	Primitives		
menus/prompts		X	X
mouse			
restricted natural language	X		X
voice			
windows		X	None
External Access:			
data bases	X	X	X
languages	Assembler, others	OPS5, Prolog	C, LISP, Others
procedural attachment	X	X	
spreadsheets	X		
other packages			
Usability:			
availability	Commercial	Commercial	Commercial
cost	945	Univ-10K/others-40K	PC-4K/others-23K
modifiable/defeatable		X	
vendor support		X	X
System Requirements:			
hardware	IBM PCs	VAX, LMI, Sun, Symbolics, TI, Xerox	Apollo, Cyber, IBM PCs, Sun, Symbolics, Tektronics, VAX
software/operating system	DOS		
Constraints:			
# rules/xK of memory	16000/512		
developer expertise	Low-Medium	High	Medium-High
Typical application(s):		Planning, Design, Diagnosis, Simultn.	Diagnosis
Other:	512K RAM	Modular	512K RAM on PCs
	Chained Knowledge modules with 16,000 rules or 256,000 facts per module.	Active Images is the KEE graphics pkg. Interface is complex.	
Author/vendor:	KDS Corporation 934 Hunter Road Wilmette, IL 60091	Intellicorp 124 University Ave. Palo Alto, CA 94301	Software A&E, Inc. 1401 Wilson Blvd. Suite 1220 Arlington, VA 22209
Reference(s):	14	7, 11, 15, 16	7, 13, 15, 16

TOOL FEATURES	KL-ONE & KL-TWO	KMS	Knowledge Craft
Knowledge Representation:			
access-based			X
decision tree			
hierarchy			X
logic-based			X
networks	Semantic		
objects/classes/frames	Concepts	X	X
procedures/rules		X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			X
algorithms			
blackboard			
chaining/rule application:			
backward		X	X
forward			X
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values	X		X
inheritance	X		X
meta-reasoning			X
pattern matching			
Problem solving:			
classification	X	X	
conflict resolution			
resolution			
Search methods:			
backtracking:			User Defined Paths
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			None
Certainty Management:			None
Fuzzy logic/sets			
Probabilistic:			
Bayesian		X	
confidence factors			
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			X
Model directed			X
Multiple/alternative DB's			
Multiple Lines of Reasoning			X

TOOL FEATURES	KL-ONE & KL-TWO	KMS	Knowledge Craft
Knowledge acquisition:			None
conflict detection			
explicit rule entry			
fact/control knowledge			
knowledge base editor	Graphical		Graphical
rules induced from examples			
User Interface			
command language			X
debugging aids - trace/help			X
explanation/history			
forms/reports			
graphics/graphic primitives			X
menus/prompts			X
mouse			X
restricted natural language			
voice			
windows			X
External Access:			
data bases			X
languages	LISP	LISP	LISP
procedural attachment	X		X
spreadsheets			
other packages			Graphic
Usability:			
availability	Research	Research	Commercial
cost			Univ-7K/Bus-50K
modifiable/defeatable			X
vendor support			X
System Requirements:			
hardware	Xerox 1100s, VAX	Univac 1100	VAX, Microvax, Symbolics, TI, LMI, Sun, Apollo, IBM RT, HP9000
software/operating system			
Constraints:			
# rules/xK of memory			
developer expertise	High	High	High
Typical application(s):	Planning, Natural language understanding.		Engineering deisgn, Process Control, Production Mgmt, Diagnosis
Other:			Research version is called SRL.
Author/vendor:	Bolt, Beranek, & Newman 50 Moulton Street Cambridge, MA 02238	Univ. of Maryland	Carnegie Group, Inc. 650 Commerce Court Station Square Pittsburgh, PA 15219
Reference(s):	2, 16	16	8, 11, 14, 15, 16

TOOL FEATURES	KNOWOL+	KRYPTON	LES
Knowledge Representation:			
access-based			X
decision tree			
hierarchy			
logic-based		X	
networks			
objects/classes/frames		X	X
procedures/rules	X		X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			X
algorithms			
blackboard			
chaining/rule application:			
backward	X		X
forward	X		X
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values			
inheritance			
meta-reasoning			
pattern matching			
Problem solving:			
classification			
conflict resolution			
resolution		X	
Search methods:			
backtracking:			
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:			X
Fuzzy logic/sets			
Probabilistic:	X		
Bayesian			
confidence factors			
Hypothesis handling:			X
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	KNOWOL+	KRYPTON	LES
Knowledge acquisition:			None
conflict detection			
explicit rule entry			
fact/control knowledge			
knowledge base editor			
rules induced from examples			
User Interface			
command language			
debugging aids - trace/help			X
explanation/history	X		Expl.
forms/reports	X		
graphics/graphic primitives			
menus/prompts			
mouse			
restricted natural language	X		
voice			
windows			
External Access:			
data bases			
languages		LISP	FORTRAN,Pascal,ADA,P 1
procedural attachment			
spreadsheets			
other packages			
Usability:			
availability	Commercial	Research	Research
cost	100		
modifiable/defeatable			
vendor support			
System Requirements:			
hardware	IBM PC & Compatible		VAX
software/operating system			
Constraints:			
# rules/xK	Medium		
developer expertise		High	High
Typical application(s):			
Other:	384K RAM & hard disk		
Author/vendor:	Intelligent Machines	Fairchild Laboratory	Lockheed Palo Alto
	New Port	for AI Research	Research Laboratory
	Richey, FL	4001 Miranda Avenue	3251 Hanover Street
		Palo Alto, CA 94304	Palo Alto, CA 94304
Reference(s):	14	16	15, 16

TOOL FEATURES	LOOPS	M.1	MARS
Knowledge Representation:	X		
access-based			
decision tree			
hierarchy			X
logic-based			
networks			
objects/classes/frames	X	Limited	
procedures/rules	X	X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms	X		
blackboard			
chaining/rule application:			
backward	X	X	X
forward	X	Limited	X
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values			
inheritance	X	Limited	
meta-reasoning			
pattern matching		X	
Problem solving:			
classification			
conflict resolution			
resolution			
Search methods:			
backtracking:			
chronological	X	X	
dependency directed			
breadth first	X		
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:			
Fuzzy logic/sets			
Probabilistic:			
Bayesian			
confidence factors	X	X	
Hypothesis handling:		None	
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	LOOPS	M.1	MARS
Knowledge acquisition:			
conflict detection			
explicit rule entry			
fact/control knowledge			
knowledge base editor	X		
rules induced from examples			
User Interface			
command language		X	
debugging aids - trace/help	X	Trace	
explanation/history	X	Expl.	Expl.
forms/reports			
graphics/graphic primitives			
menus/prompts		X	
mouse			
restricted natural language		X	
voice			
windows		X	
External Access:			
data bases	X	X	
languages	LISP	C, Prolog	MRS
procedural attachment	X	X	
spreadsheets			
other packages	Graphics		
Usability:			
availability	Commercial	Commercial	Experimental
cost	300	12,500	
modifiable/defeatable		X	
vendor support	X	X	
System Requirements:			
hardware	Xerox 1100s	IBM PCs & Com.	
software/operating system		DOS	
Constraints:			
# rules/xK of memory		200/128	
developer expertise	High	Low-Medium	High
Typical application(s):		Structural analysis, Simulation	
		Diagnosis	
Other:	Upgraded KRL	128K RAM + color	MRS is also an expert
		graphics	system develpmt. tool
Author/vendor:	Xerox PARC	Teknowledge, Inc.	Stanford University
	3333 Coyote Hill Rd.	525 University Ave.	
	Palo Alto, CA 94304	Palo Alto, CA 94304	
Reference(s):	7, 18	7,10,13,15,16,PC	16

TOOL FEATURES	MELD	MICE	MicroExpert
Knowledge Representation:			
access-based	X		
decision tree			
hierarchy			
logic-based			
networks		Semantic	Semantic
objects/classes/frames	X	X	
procedures/rules	X	X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms			
blackboard			
chaining/rule application:			
backward	X	X	
forward	X	X	
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values			
inheritance			
meta-reasoning	X		
pattern matching			
Problem solving:			
classification			
conflict resolution	X		
resolution		X	
Search methods:			
backtracking:			
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow		X	
time-dependent			
truth maintenance system			
Certainty Management:	X		
Fuzzy logic/sets			
Probabilistic:			
Bayesian			X
confidence factors		X	
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	MELD	MICE	MicroExpert
Knowledge acquisition:			
conflict detection			
explicit rule entry		X	
fact/control knowledge		Facts	
knowledge base editor		X	
rules induced from examples			
User Interface			
command language			
debugging aids - trace/help		X	
explanation/history		X	
forms/reports		X	
graphics/graphic primitives		X	
menus/prompts		X	
mouse		X	
restricted natural language		X	
voice			
windows		X	
External Access:			
data bases		X	
languages	OPS5	C	Pascal
procedural attachment		X	
spreadsheets			
other packages			
Usability:			
availability	Research	Commercial	Commercial
cost		20K	
modifiable/defeatable			
vendor support		X	
System Requirements:			
hardware		IBM PCs & Com.	Microcomputers
software/operating system		DOS	
Constraints:			
# rules/xK of memory		200/512	
developer expertise	High	Low	Medium
Typical application(s):	Diagnosis		
Other:		512K RAM + mouse	
		+ color capability	
Author/vendor:	Westinghouse	Machine Intelligence	Isis Systems, Ltd.
	Research and	Corp.	11 Oakdene Road
	Development Center	1539 Locust Avenue	Redhill
		Bohemia, NY 11716	Surrey RH1 6BT, England
Reference(s):	16	14, Author	3

TOOL FEATURES	MORE	MRS	NETL
Knowledge Representation:			
access-based		X	
decision tree		X	
hierarchy			
logic-based		X	
networks			Semantic
objects/classes/frames			X
procedures/rules		X	
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism		X	
algorithms			
blackboard		X	
chaining/rule application:			
backward		X	
forward		X	
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values		X	
inheritance			X
meta-reasoning		X	
pattern matching			
Problem solving:			
classification			
conflict resolution			
resolution		X	
Search methods:			
backtracking:			
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:	X		
Fuzzy logic/sets			
Probabilistic:			
Bayesian			
confidence factors			
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's		X	X
Multiple Lines of Reasoning			

TOOL FEATURES	MORE	MRS	NETL
Knowledge acquisition:			
conflict detection	X		
explicit rule entry			
fact/control knowledge	X		
knowledge base editor	X	X	
rules induced from examples	X		
User Interface			
command language			
debugging aids - trace/help		Trace	
explanation/history		Expl.	
forms/reports			
graphics/graphic primitives			
menus/prompts			
mouse			
restricted natural language			
voice			
windows			
External Access:			
data bases			
languages		LISP	LISP
procedural attachment		X	
spreadsheets			
other packages		Graphics	
Usability:			
availability	Research	Research	Research
cost			
modifiable/defeatable			
vendor support			
System Requirements:			
hardware			
software/operating system			
Constraints:			
# rules/xK of memory			
developer expertise	High	High	High
Typical application(s):	Diagnosis		
Other:			
Author/vendor:	CMU	Stanford University	MIT
	Dept of Computer		
	Science		
Reference(s):	16	6, 16	16

TOOL FEATURES	NEXPERT	OPS5	OPS5+
Knowledge Representation:			
access-based			
decision tree			
hierarchy			
logic-based			
networks			
objects/classes/frames		Limited	Limited
procedures/rules	X	X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms			
blackboard		X	X
chaining/rule application:			
backward	X	None	None
forward	X	X	X
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values			
inheritance	X		
meta-reasoning		Limited	
pattern matching		X	
Problem solving:			
classification	X		
conflict resolution		X	
resolution		None	
Search methods:			
backtracking:			
chronological		Limited	
dependency directed			
breadth first		Limited	
opportunistic			
pruning:			
minimax			
shallow			
time-dependent		Time Tags	
truth maintenance system			
Certainty Management:			None
Fuzzy logic/sets			
Probabilistic:			
Bayesian			
confidence factors			
Hypothesis handling:		None	None
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	NEXPERT	OPS5	OPS5+
Knowledge acquisition:		None	None
conflict detection			
explicit rule entry			
fact/control knowledge			
knowledge base editor		Limited	
rules induced from examples			
User Interface			
command language			
debugging aids - trace/help		X	
explanation/history		History	
forms/reports			
graphics/graphic primitives	Graphics		
menus/prompts	X		X
mouse	X		X
restricted natural language		None	
voice			
windows	X	X	X
External Access:			
data bases			
languages		BLISS, LISP	X
procedural attachment			
spreadsheets			
other packages		Graphics	
Usability:			
availability	Commerical	Commercial	Commercial
cost	5000	O=3K/S=10K	3K
modifiable/defeatable			
vendor support			
System Requirements:			
hardware	512K MacIntosh	Symbolics, VAX, Xerox	IBM PCs & Com, 512K MacIntosh
software/operating system			
Constraints:			
# rules/xK of memory			1500/640
developer expertise	Low	High	Low-Medium
Typical application(s):		Computer Component Configuring,Planning	
Other:		Unsophisticated Development, Environment Blackboard can be examined.	640K RAM + mouse & graphics on PCs. PC Version of OPS5
Author/vendor:	Nemron Data, Inc. 444 High Street Palo Alto, CA 94301	Digital Equip. Corp. 77 Reed Road Hudson, MA 01749	Computer Thought Corp. 1721 W. Plano Pkwy, #12? Plano, TX 75075
Reference(s):	13	6, 7, 15, 16	15

TOOL FEATURES	OPS83	OWL	PC+
Knowledge Representation:			
access-based			
decision tree			
hierarchy			X
logic-based			
networks		Semantic	Semantic
objects/classes/frames	Limited	X	X
procedures/rules	X		
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms			
blackboard			
chaining/rule application:			
backward	Limited		X
forward	X		X
parallel			
recursive/nested			
sequential/rule order			X
constraint propagation			
default values			
inheritance		X	X
meta-reasoning			X
pattern matching			
Problem solving:			
classification			
conflict resolution	User Defined		
resolution			
Search methods:			
backtracking:			
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:	None		
Fuzzy logic/sets			
Probabilistic:			
Bayesian			
confidence factors			X
Hypothesis handling:			X
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	OPS83	OWL	PC+
Knowledge acquisition:	None		X
conflict detection			
explicit rule entry			
fact/control knowledge			
knowledge base editor			X
rules induced from examples			
User Interface			
command language			
debugging aids - trace/help	Trace		Trace
explanation/history			X
forms/reports			
graphics/graphic primitives			
menus/prompts			
mouse			
restricted natural language			
voice			
windows			
External Access:			
data bases			X
languages	Several	LISP, Machine Lang.	LISP
procedural attachment	X		X
spreadsheets			
other packages			
Usability:			
availability	Commercial	Research	Commerical
cost	2500		4500
modifiable/defeatable			
vendor support			X
System Requirements:			
hardware	Apollo, Data General AT&T, HP, VAX, Sun, Tektronix, IBM PCs & Com.		IBM PCs, TI PC
software/operating system			DOS
Constraints:			
# rules/xK of memory			400/512
developer expertise	Medium	High	Medium-High
Typical application(s):			Diagnosis
Other:	Compiled version of OPS5.		512KRAM + hard disk Supports Color
Author/vendor:	Production Systems Technologies, Inc. 642 Gettysburg St. Pittsburgh, PA 15206	MIT	Texas Instruments Computer Sciences Lab PO Box 226015 Dallas, TX 75266
Reference(s):	13, 15, 16	15	7, 10, 13, 15, 16, 1C

TOOL FEATURES	PICON	PIE	PLUME
Knowledge Representation:			
access-based			
decision tree			
hierarchy			
logic-based			
networks			
objects/classes/frames	X		X
procedures/rules	X	X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms			
blackboard			
chaining/rule application:			
backward	X		
forward	X		
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values			
inheritance			
meta-reasoning			
pattern matching			
Problem solving:			
classification			
conflict resolution			
resolution			
Search methods:			
backtracking:			
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:			
Fuzzy logic/sets			
Probabilistic:			
Bayesian			
confidence factors			
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning	X		

TOOL FEATURES	PICON	PIE	PLUME
Knowledge acquisition:			
conflict detection			
explicit rule entry			
fact/control knowledge			
knowledge base editor	X		X
rules induced from examples			
User Interface			
command language			
debugging aids - trace/help			X
explanation/history	X		
forms/reports			
graphics/graphic primitives	Graphics		
menus/prompts			
mouse			
restricted natural language			
voice			
windows			
External Access:			
data bases			
languages	C, LISP	SMALLTALK-76	LISP
procedural attachment			
spreadsheets			
other packages			
Usability:			
availability	Commercial	Experimental	Commercial
cost			
modifiable/defeatable			
vendor support			
System Requirements:			
hardware	LMI Lambda Plus		VAX, Symbolics
software/operating system			
Constraints:			
# rules/xK of memory			
developer expertise	Medium	High	High
Typical application(s):	Process Control	Extend SMALLTALK	Natural Language Interfaces to Expert Systems
Other:			
Author/vendor:	LISP Machine, Inc.	Xerox PARC	Carnegie Group, Inc.
	6033 W. Century Bl.	3333 Coyote Hill Rd.	650 Commerce Court
	Suite 900	Palo Alto, CA 94304	at Station Square
	Los Angeles,CA 90045		Pittsburgh, PA 15219
Reference(s):	16	16	16

TOOL FEATURES	PRISM	PSYCO	RITA
Knowledge Representation:			
access-based			
decision tree			
hierarchy	X		
logic-based			
networks		Frame	
objects/classes/frames		X	
procedures/rules	X	X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms			
blackboard			
chaining/rule application:			
backward	X		X
forward	X	X	X
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values			
inheritance			
meta-reasoning			
pattern matching			
Problem solving:			
classification			
conflict resolution		X	
resolution			
Search methods:			
backtracking:			
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:	X		
Fuzzy logic/sets			
Probabilistic:			
Bayesian			
confidence factors			
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	PRISM	PSYCO	RITA
Knowledge acquisition:			
conflict detection			
explicit rule entry	X		X
fact/control knowledge	X		
knowledge base editor			X
rules induced from examples			
User Interface			
command language			
debugging aids - trace/help			Trace
explanation/history			Expl.
forms/reports			
graphics/graphic primitives			
menus/prompts			
mouse			
restricted natural language	X		
voice			
windows			
External Access:			
data bases			
languages	Pascal		C
procedural attachment			X
spreadsheets			
other packages			
Usability:			
availability	Research	Research	Research
cost			
modifiable/defeatable			
vendor support			
System Requirements:			
hardware	IBM 370		PDP-11/45, 70
software/operating system	VM/CMS		UNIX
Constraints:			
# rules/xK of memory			
developer expertise	High	High	High
Typical application(s):		Models of Human Decision Making	
Other:			
Author/vendor:	IBM Palo Alto Scientific Research Center 1530 Page Mill Rd. Palo Alto, CA 94304	Imperial Cancer Research Fund & Queen's Medical Center	Rand Corporation 1700 Main Street PO Box 2138 Santa Monica,CA 90406
Reference(s):	16	16	16

TOOL FEATURES	RLL	ROGET	ROSIE
Knowledge Representation:			
access-based			
decision tree			
hierarchy			X
logic-based			
networks			
objects/classes/frames	X		X
procedures/rules		X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism	X		
algorithms			
blackboard			
chaining/rule application:			
backward		X	X
forward		X	X
parallel			
recursive/nested			X
sequential/rule order			
constraint propagation			
default values			
inheritance	X		
meta-reasoning			
pattern matching			X
Problem solving:			
classification			
conflict resolution			
resolution			
Search methods:			
backtracking:			
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:		X	
Fuzzy logic/sets			
Probabilistic:			
Bayesian			
confidence factors			
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	RLL	ROGET	ROSIE
Knowledge acquisition:			None
conflict detection			
explicit rule entry			
fact/control knowledge			
knowledge base editor	X		X
rules induced from examples			
User Interface			
command language			
debugging aids - trace/help			Trace
explanation/history			History
forms/reports			
graphics/graphic primitives			
menus/prompts			
mouse			
restricted natural language			X
voice			
windows			
External Access:			
data bases			
languages	LISP	LISP	C, LISP
procedural attachment	X	X	X
spreadsheets			
other packages			
Usability:			
availability	Research	Experimental	Research
cost			
modifiable/defeatable			
vendor support			
System Requirements:			
hardware			
software/operating system			
Constraints:			
# rules/xK of memory			
developer expertise	High	Medium-High	Medium-High
Typical application(s):		Medical Diagnosis	Planning, Intelligence Analysis
Other:			Good NL Interface (can give false sense of security)
Author/vendor:	Stanford University	Stanford University	Rand Corporation 1700 Main Street PO Box 2138 Santa Monica, CA 90406
Reference(s):	16	16	6, 16

TOOL FEATURES	RuleMaster	S.1	SAGE
Knowledge Representation:			
access-based		None	
decision tree	X		
hierarchy	X		
logic-based			
networks			
objects/classes/frames	X	Limited	
procedures/rules	X	X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms		X	
blackboard			
chaining/rule application:			
backward	X	X	X
forward	None	None	Limited
parallel			
recursive/nested	X		
sequential/rule order			
constraint propagation		Relations	
default values			
inheritance		None	
meta-reasoning			
pattern matching			
Problem solving:			
classification			
conflict resolution			
resolution			
Search methods:			
backtracking:			
chronological		X	
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:			
Fuzzy logic/sets	X		
Probabilistic:			
Bayesian			
confidence factors		X	
Hypothesis handling:	None		
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	RuleMaster	S.1	SAGE
Knowledge acquisition:		X	
conflict detection		X	
explicit rule entry	X		X
fact/control knowledge			
knowledge base editor	X	X	
rules induced from examples	X		
User Interface			
command language		X	
debugging aids - trace/help		X	Trace/Advise
explanation/history	Expl.	X	Expl.
forms/reports			
graphics/graphic primitives		Graphics	
menus/prompts		X	
mouse		X	
restricted natural language	X	X	
voice			
windows		X	
External Access:			
data bases		X	
languages	Several	C, LISP	Pascal
procedural attachment	X	X	X
spreadsheets			
other packages			
Usability:			
availability	Commercial	Commerical	Commercial
cost		Univ. 4K/Bus. 30K	
modifiable/defeatable			
vendor support	X	X	
System Requirements:			
hardware	Apollo, Sun, IBM PCs, VAX	Apollo, Sun, VAX, NCR, Xerox, HP, IBM RT, Symbolics	VAX, PDP, Prime
software/operating system	UNIX, DOS, VMS		
Constraints:			
# rules/xK of memory	1000/640		
developer expertise	Medium	High	Medium
Typical application(s):	Storm Forecasting, Fault Diagnosis	Structured Selection Problems, Diagnosis	
Other:		Cost of object code only varies with the type of hardware.	
Author/vendor:	Radian Corporation 8501 Mo-Pac Blvd. PO Box 9948 Austin, TX 78766	Tecknowledge, Inc. 1850 Embarcadero Rd. PO Box 10119 Palo Alto, CA 94304	SP1 International The Charter Abingdon Oxon OX14 3L2 England
Reference(s):	10, 13, 15, 16	7, 11, 15, 16	3

TOOL FEATURES	SAVIOR	SMALL-X	Teiresias
Knowledge Representation:	X		
access-based			
decision tree			
hierarchy			
logic-based			
networks			
objects/classes/frames			X
procedures/rules	X	X	
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms			
blackboard			
chaining/rule application:			
backward	X	X	
forward	X	X	
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values			
inheritance			
meta-reasoning			
pattern matching		X	
Problem solving:			
classification			
conflict resolution			
resolution			
Search methods:			
backtracking:			
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:			
Fuzzy logic/sets			
Probabilistic:			
Bayesian			
confidence factors	X		
Hypothesis handling:			
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	SAVIOR	SMALL-X	Teiresias
Knowledge acquisition:			
conflict detection			X
explicit rule entry			X
fact/control knowledge			
knowledge base editor			X
rules induced from examples			
User Interface			
command language			
debugging aids - trace/help	Help		X
explanation/history	Expl.		Expl.
forms/reports			
graphics/graphic primitives			
menus/prompts	X		
mouse			
restricted natural language			X
voice			
windows			
External Access:			
data bases			
languages		DOS Commands	LISP
procedural attachment			
spreadsheets			
other packages			
Usability:			
availability	Commercial	Commercial	Research
cost		225	
modifiable/defeatable			
vendor support			
System Requirements:			
hardware	IBM, VAX	IBM PCs & Com	
software/operating system		DOS	
Constraints:			
# rules/xK of memory		1900/640	
developer expertise	Medium	Low	Medium-High
Typical application(s):			
Other:		128K RAM	
Author/vendor:	ISI Ltd.	RK Software	Stanford University
	11 Oakdene Road		
	Redhill		
	Surrey RH1 6BT, Eng.		
Reference(s):	13, 16	14	16

TOOL FEATURES	TIMM and TIMM-PC	TOPSI	UNITS
Knowledge Representation:			
access-based			
decision tree	Matrix		
hierarchy			X
logic-based			
networks			Semantic
objects/classes/frames	X		X
procedures/rules	X	X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms	X		
blackboard			
chaining/rule application:			
backward	None		
forward	X		
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values			
inheritance	None		X
meta-reasoning	Rule Induction		
pattern matching	X		X
Problem solving:			
classification			
conflict resolution			
resolution			
Search methods:			
backtracking:			
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:			
Fuzzy logic/sets			
Probabilistic:			
Bayesian			
confidence factors	X		
Hypothesis handling:	X		
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			
Multiple Lines of Reasoning			

TOOL FEATURES	TIMM and TIMM-PC	TOPSI	UNITS
Knowledge acquisition:	X		
conflict detection	X		
explicit rule entry	X		
fact/control knowledge			
knowledge base editor	.X	X	
rules induced from examples	X		
User Interface			
command language	X		
debugging aids - trace/help	X		
explanation/history	Expl.		Expl.
forms/reports			
graphics/graphic primitives			
menus/prompts	X	X	
mouse			
restricted natural language	X		X
voice			
windows			
External Access:			
data bases			
languages	FORTRAN	C, Pascal	LISP
procedural attachment			
spreadsheets			
other packages			
Usability:			
availability	Commercial	Commercial	Commercial
cost	PCs-5K/VAX-39,500	375	
modifiable/defeatable			
vendor support	X	X	
System Requirements:			
hardware	VAX, IBM PCs & Com	IBM PCs & Com	
software/operating system		CPM, DOS, VMS, UNIX	TENEX or TOPS20
Constraints:			
# rules/xK of memory	500/640		
developer expertise	Low	Medium	High
Typical application(s):			
Other:	TIMM-PC requires	512K RAM on PCs.	
	640K RAM + 10 MB	65K RAM on CPM.	
	hard disk + math		
	coprocessor.		
	Poor output use		
	interface.		
Author/vendor:	General Research Cp.	Dynamic Master	Intelligenetics
	7655 Old Springhouse	Systems, Inc.	
	Road	PO Box 566456	
	McLean, VA 22102	Atlanta, GA 30356	
Reference(s):	7,10,13,14,15,16,PC	13, 14	16

TOOL FEATURES	VIE-PCX	Xsys-II	GEBST
Knowledge Representation:			
access-based			
decision tree			
hierarchy		X	Multiple
logic-based			
networks			
objects/classes/frames	X	X	Objects
procedures/rules	X	X	X
spreadsheet(s)/data base(s)			
Control & Inference Mechanisms:			
agenda mechanism			
algorithms			
blackboard			
chaining/rule application:			
backward		X	X
forward		X	X
parallel			
recursive/nested			
sequential/rule order			
constraint propagation			
default values			
inheritance			X
meta-reasoning	X		
pattern matching			
Problem solving:			
classification			
conflict resolution			
resolution			
Search methods:			
backtracking:			User defined
chronological			
dependency directed			
breadth first			
opportunistic			
pruning:			
minimax			
shallow			
time-dependent			
truth maintenance system			
Certainty Management:		X	
Fuzzy logic/sets			Dempster/Schafer
Probabilistic:			User definable
Bayesian			
confidence factors			
Hypothesis handling:	X		
Group & differentiate			
Hypothetical worlds			
Model directed			
Multiple/alternative DB's			X
Multiple Lines of Reasoning			

TOOL FEATURES	VIE-PCX	XSYS-II	GESBT
Knowledge acquisition:			
conflict detection			
explicit rule entry			X
fact/control knowledge			X
knowledge base editor			X
rules induced from examples			
User Interface			
command language			
debugging aids – trace/help		X	X
explanation/history		X	X
forms/reports			
graphics/graphic primitives			
menus/prompts		X	X
mouse			X
restricted natural language			
voice			
windows			X
External Access:			
data bases		X	
languages		C, LISP	Pascal
procedural attachment		X	C
spreadsheets			
other packages			
Usability:			
availability	Commercial	Commercial	Commercial
cost	300	995	S=1K,M=2.5K,U=5K*
modifiable/defeatable			
vendor support		X	
System Requirements:			
hardware	IBM PCs & Com	IBM PCs	Symbolics, IBM PCs
software/operating system		IQLISP	LISP
Constraints:			
# rules/xK of memory			
developer expertise	High	Low	High
Typical application(s):			
Other:	512K RAM, Austrian	640K RAM	
Author/vendor:	AI Schottengasse 3 A-1010 Vienna, Austria	California Intelligence 912 Powell St., #8 San Francisco, CA 94108	SAIC AI & Decision Aids Division Mail Stop T-6-3 1710 Goodridge Dr. McLean, VA 22102
Reference(s):	13,14	14	12

*S=Single computer, M=Less than 11 computer, U=Unrestricted